

**Remarks as Prepared for Delivery by  
Deputy Administrator,  
Philip R .Recht  
ITS Benefits Panel  
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## **Introduction**

It is a pleasure for me to be on this panel to talk about the safety benefits of ITS countermeasures for Collision Avoidance. NHTSA has been involved in the DOT ITS program from its inception and continue to provide leadership on safety systems and related issues within the program. Early-on in the program, we recognized the need to develop a strategic organized approach to ensure the development of meaningful intelligent collision avoidance systems.

### **Slide 1**

The critical first step is a comprehensive crash data assessment to develop an understanding of the safety problem. We have completed a thorough analysis of real-world accident data files, including detailed analysis of individual crashes. The results of this analysis have quantified the red-world crash problem by distributing the 6.4 million crashes into various collision types. We found that roadway departure crashes, rear-end collisions, intersection collisions, and lane change and merge crashes comprise a large portion of the total crash safety problem.

### **Slide 2**

For these crashes, we then determined the factors which caused these crashes. Our analysis concluded-that about 90 percent of crashes result from driver-related factors, including 76 percent that involve driving task errors such as drivers not recognizing a hazardous situation until it is too late to do anything about it (inattention, looked but did not see) or drivers making the wrong decision (tailgating, excessive speed), and 14 percent involve drivers in a poor physiological state (drunk, asleep, ill).

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### Slide 3

Based on the magnitude of the safety problem and the causal factors involved, we are establishing performance specifications to specify the technical attributes of systems that can reduce these collisions. We currently have projects to develop countermeasures for various crash conditions, including Road Departure Crashes, Rear-End Crashes, Backing Crashes, Lane Change and Merge Crashes, and Intersection Crashes. As we develop these systems, a critical component of our program is to estimate the safety benefits that could be provided to the driving public by these ITS collision avoidance systems. Estimates of the number of collisions that will be avoided and the resulting reductions in property damage costs, deaths, and injuries are needed to provide guidance on program direction and, of equal importance, to be able to share with the U.S. taxpayers, evidence that their money is being well spent. Last October, I announced at the ITS World Congress in Japan that we were initiating an effort to estimate ITS safety benefits. NHTSA's internal effort includes Engineers, Statisticians, Economists, and other Safety Specialists from the agency. The process involved a group of three to four experts addressing a specific crash condition, reviewing data from experiments using countermeasures that can reduce these crashes, and estimating the effectiveness value for a specific countermeasure. The entire group reviewed the methodology used for each countermeasure, the effectiveness values, and the safety benefits calculated for each and then reached consensus on the results. This task force is in the process of fully documenting the analysis which is the basis for these findings. A NHTSA report documenting the efforts of the task force will be released this summer. We will seek comments, through appropriate means, from the public and other interested parties on the process and results of the study. This input will be useful as we develop improved methodologies, estimates, gather additional data, and refine our preliminary safety benefit estimates.

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This effort concentrated on developing a methodology for benefits assessment by comparing the estimated number of collisions when driving without an ITS collision avoidance system to the number expected when driving with a collision avoidance system -- the difference being the estimated benefit. These estimates should not only help NHTSA make decisions about the direction of the ITS Crash Avoidance Program, but will also assist the ITS community in making decisions on the most cost-effective allocation of resources towards research and development of ITS collision avoidance systems.

So far, NHTSA has developed estimates of the number of crashes that could be reduced by ITS systems in three of these crash conditions--roadway departure crashes, rear-end crashes, and lane change and merge crashes. These crash conditions account for 3.1 million of the 6.4 million crashes.

#### **Discussion of Approach Used in Estimating Benefits**

### **Slide 4**

For each crash condition, we estimated the safety benefits of ITS countermeasures. The first step was to define the relevant crashes. Each countermeasure is capable of addressing only certain crash scenarios under each of the various crash conditions. These subsets are defined as relevant crashes. The crashes that could be prevented with an ITS system are calculated as the product of the number of relevant crashes in a crash condition and the effectiveness of the countermeasure system under consideration, and then summing them for all crash scenarios. To estimate each effectiveness value, a mathematical model was constructed to describe the crash condition and analyze individual crash scenarios within that condition, their likelihood of the occurrence, and

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then estimating the number of crashes reduced, i.e., an effectiveness value of the countermeasure for each crash scenario.

## **Slide 5**

The basic data for estimating effectiveness come from studies such as those using driving simulators where subjects drove through a simulated roadway course that contained curves and other features which are often associated with accidents. Similarly, data on driver reaction times and other features, such as braking capability were obtained and used as input to a computer model.

Additionally, data from experiments in which drivers were asked to follow a specified route on sections of public roads where drivers drove vehicles with and without prototype countermeasures along predetermined route on local highways were used. Expert judgements were also occasionally used by the task force when experimental or simulator data were not available. It should be noted that in estimating effectiveness certain assumptions were necessary. For example, it is assumed that the market penetration is 100 percent for these systems and they are assumed to be in continuous use. Further, it is assumed that the drivers unilaterally respond to the warnings and alerts given by the vehicle and take the necessary evasive actions, and that system reliability is 100 percent. Finally, it is assumed that the effects of false alarms and risk compensation (i.e., driving in a more risky manner in an ITS--quipped vehicle) was negligible.

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Summary of results**Slide 6****Roadway Departure Countermeasure System**

An example will further describe the Process used to estimate benefits. Each year, there are some 1.2 million roadway departure crashes. In a roadway departure crash, the ITS system is expected to detect the potential that the vehicle is going to depart the road. The system would utilize information regarding the position and speed of the vehicle, in combination with information about the geometry of the road ahead to determine if the vehicle's current position, speed, and orientation would likely lead to a roadway departure. If such an event is likely, the driver is alerted through audio or other type of signals to indicate the need for corrective action.

Based on roadway departure crash studies using a driving simulator, ITS system effectiveness was estimated as 80 percent for inattentive drivers on dry roadways. It is conservatively assumed that the countermeasure would be at least as effective when used by alert-drivers. Studies conducted on driving performance of drivers who had been drinking (not intoxicated) indicate driving performance degrades by about 8 percent, or about 92 percent of the level for unimpaired drivers. Similar degradation is assumed for drowsy drivers. Thus, for impaired or drowsy drivers, the effectiveness of this system would be reduced to about 70 percent,  $((.92) \times (.80))$ . The role of other factors, such as roadway geometry, presence of shoulders, on the effectiveness-is also included. Using all this information, the overall effectiveness value for the roadway departure countermeasure system is estimated at 65 percent for the relevant crashes.

Since there are some 458,000 relevant crashes, such a system would reduce these crashes to 296,000.

**Lane Change/Merge Crash Avoidance System**

The system will measure distance to and speed of vehicles in adjacent lanes along the full length and to the rear of the host vehicle. If there are no indications of lane change start (e.g., turn signals are not used or the vehicle has not begun moving toward the adjacent lane), the system simply presents an easily-detectable visual alert whenever and for as long as there is a vehicle in an adjacent lane. If there is another vehicle present and turn signals are activated (or there is some other indication that the vehicle has begun moving toward the adjacent lane), this system provides the driver with a visual, auditory, or some other feedback to augment the visual alerts.

The lane change maneuver involves a decision phase where the driver gathers information about other vehicles in the adjacent lanes to decide whether or not to start the lane change. The crash records indicate that lane change/merge crash-involved drivers are largely unaware of other vehicles in the adjacent lanes. Therefore, the lane change/merge crash avoidance system has the potential to alert the driver in the decision phase so as to prevent the execution of the ill-advised maneuver. The effectiveness of such a system in supporting the decision to change lanes rests on the probability that the driver and/or the system will detect the hazard. The estimated effectiveness for lane change decision phase driver support is approximately 20 percent for the relevant crashes. Thus, 39,000 of all police reported lane change and merge crashes could be avoided by such a system.

**Rear-End Crash, Driver Warning Systems**

Annually, some 1.7 million rear-end crashes occur. Here the ITS system would monitor the forward path of the vehicle and the headway to a lead vehicle in front and provide warning to its driver if it presents a potentially dangerous situation. The display in the vehicle consists of a graphical display and an auditory voice warning. Various scenarios are considered in estimating

the effectiveness of the system. The two scenarios are “lead vehicle moving” and “lead vehicle stopped.” Separate effectiveness values for the above two crash scenarios and crash circumstances such as dry and wet/icy road conditions were determined. These were considered in determining the overall effectiveness. Overall, the effectiveness of this system is estimated at 49 percent for the target crashes. Thus, the number of crashes avoided with this system is 759,000 crashes. The total number of crashes that could be reduced by the roadway departure, lane change and merge, and rear-end crash warning countermeasure is about 1.1 million crashes.

### **Economic Benefits**

## **Slide 7**

In addition to the crash reduction benefits that ITS can provide, there are also economic benefits associated with the reduced crashes and their associated fatalities and injuries. NHTSA has estimated that motor vehicle crashes cost about \$137 billion, annually. At this time, we do not have estimates of crash costs by each relevant crash condition. As a first approximation of economic benefits, we can apply the previously discussed effectiveness estimates to the crash costs. The ITS systems discussed could provide an estimated overall effectiveness or crash reduction, of 17 percent. Thus, the economic benefits of these systems would be  $(0.17)(\$137 \text{ billion}) = \$23 \text{ billion}$ .

These economic potential benefits are then compared to the cost of ITS countermeasures to estimate the net benefits, i.e., potential economic benefits - ITS countermeasure costs which could be expected from deployment of these systems. Since, the production costs of ITS countermeasures is unknown at this time, we can use a range of costs, from \$100 to \$2000 per car, and calculate the net benefit. As is shown, the figure presents the annual potential economic



benefits of \$23 billion and the annual fleet costs for the ITS system discussed, as a function of unit system costs. The net economic benefits range from approximately \$3 to 22 billion depending upon the cost of the countermeasure systems described today.

## **Conclusions**

In summary, from just these four countermeasures described, NHTSA is estimating that if all vehicles were equipped, motor vehicle crashes would be reduced by 17 percent and over 1.1 million crashes could be avoided. This 17 percent effectiveness relates to \$23 billion in cash cost savings if the associated countermeasures described in this presentation are deployed in the entire fleet.

This brief presentation has presented an overview of our methodology. As I previously mentioned, to ensure a thorough and sound technical assessment, we plan to release a NHTSA report presenting the details of the analysis used to estimate these benefits, this summer. We will seek comments on this report from our partners through appropriate means to ensure adequate peer review. These comments will be valuable as we develop improved methodologies and refine our preliminary safety benefit estimates. I encourage you to participate in our development of ITS benefits assessment.

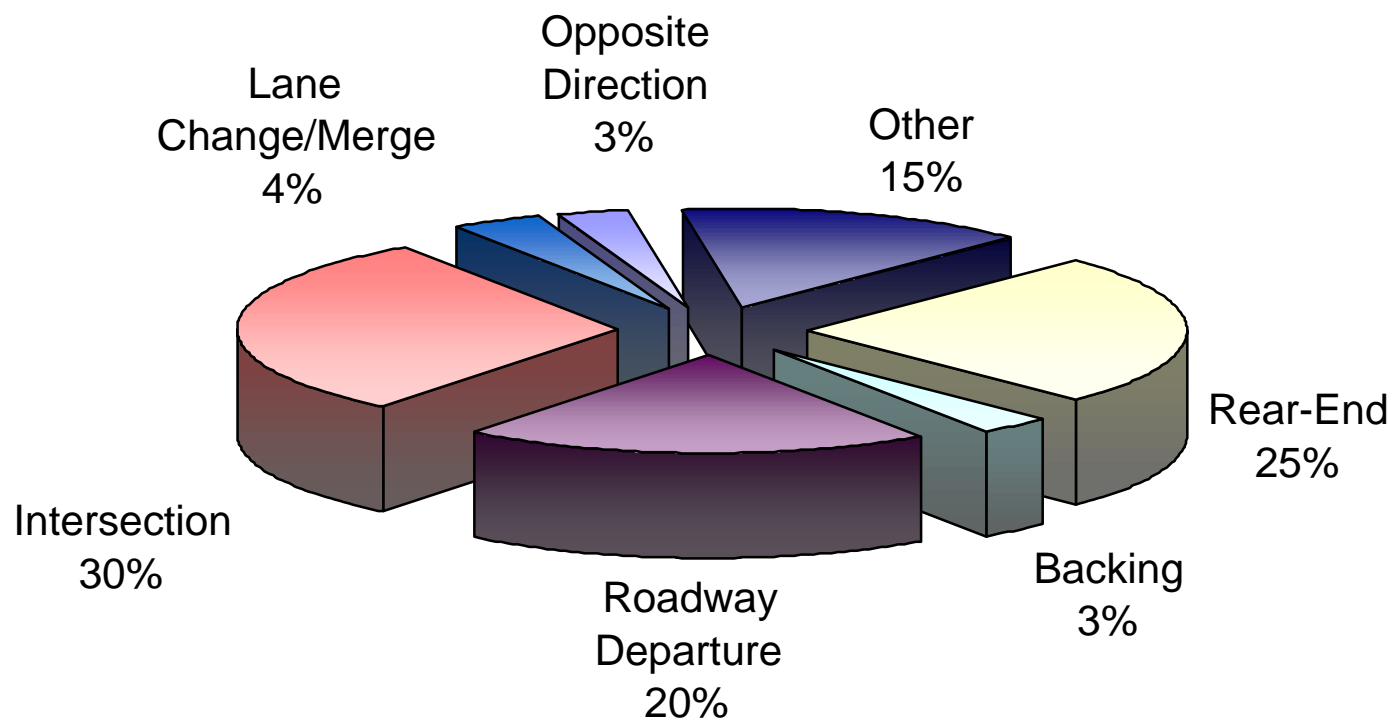


***Benefits Assessment  
of Selected  
Crash Avoidance Countermeasures  
Using ITS Technologies***

***Philip Recht  
Deputy Administrator***

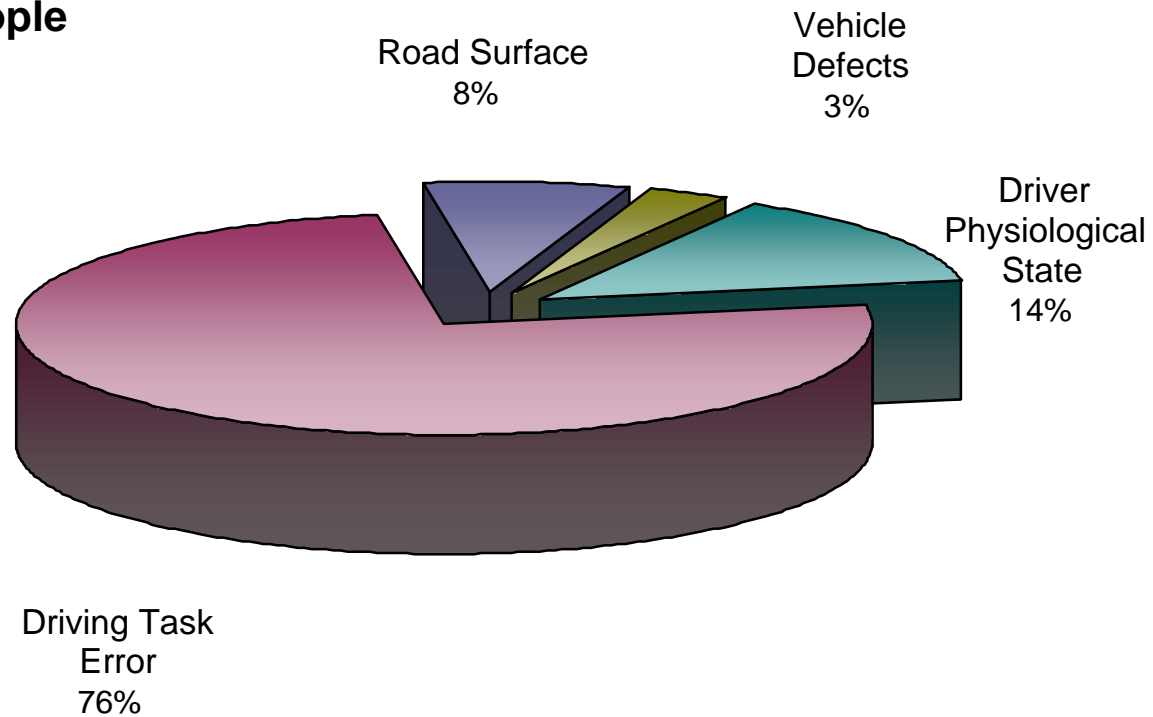
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## ***Target Crash Problem Size 6.4 Million Crashes Annually***



## ***Causal Factor Distribution***

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## ***Current Projects for Countermeasure Development***

- *Roadway Departure Crashes*
- *Rear-End and Backing Crashes*
- *Lane Change and Merge Crashes*
- *Intersection Crashes*

# ***Benefit Assessment Methodology***

- *Determine Relevant Crashes*
- *Develop Effectiveness Estimates*
- *Calculate Safety Benefits*

**Safety Benefits = Sum of Relevant  
Target Crashes X Effectiveness**

# ***Effectiveness Estimates Process***

- *Current Analysis of Effectiveness Based On:*
  - *Driving Simulations*
  - *Computer Models*
  - *Test Track Experiments*
  - *Expert Judgment*

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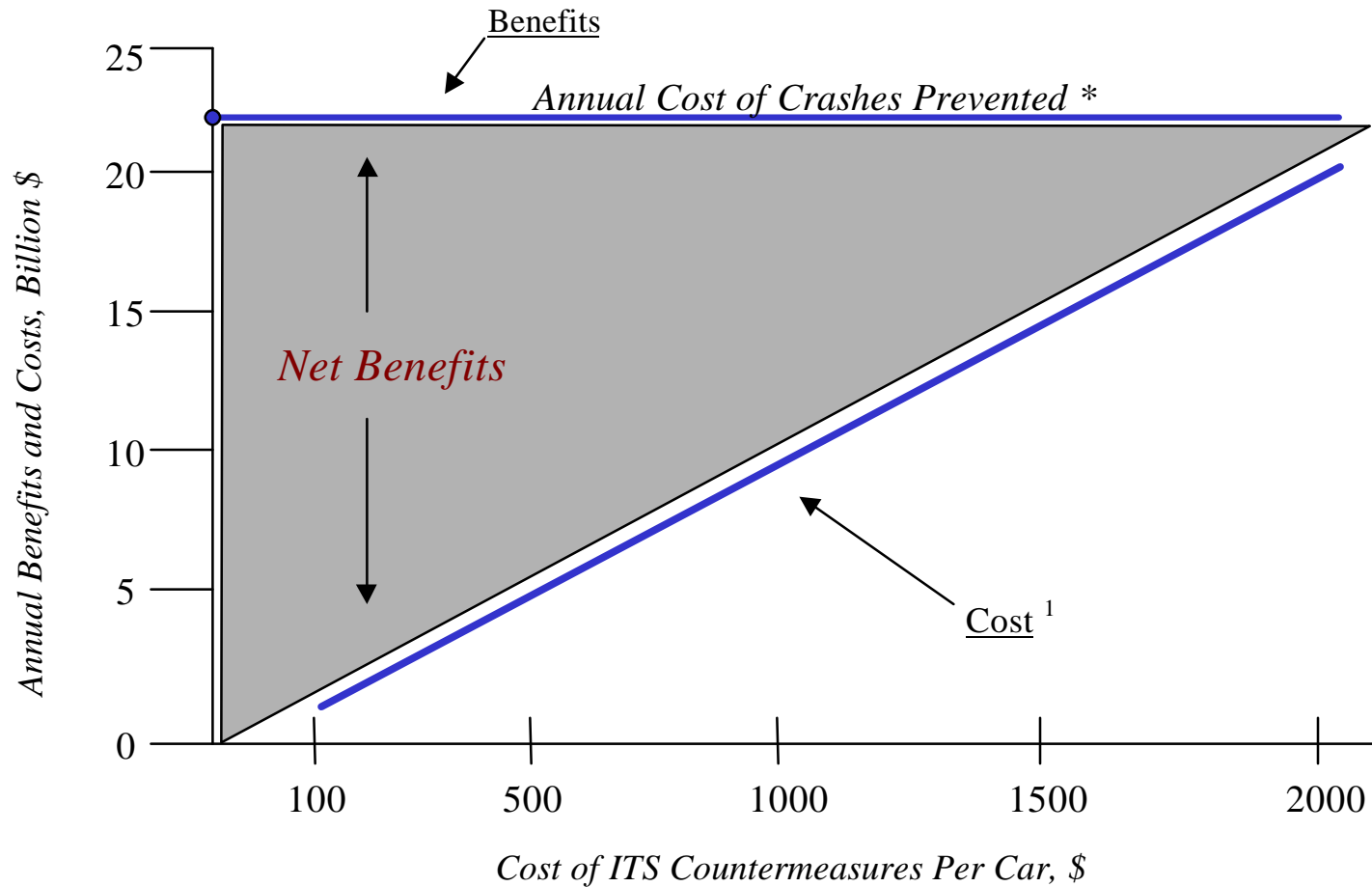
## ***Crashes Prevented By Selected Crash Avoidance Systems***

<b>Crash Condition (1)</b>	<b>Total No. of Crashes (2)</b>	<b>Relevant Crashes Addressed by Countermeasures (3)</b>	<b>Effectiveness Estimates (4)</b>	<b>Number of Crashes Reduced (3) x (4)</b>
<b>Roadway Departure</b>	1.2 million	458,000	0.65	296,000
<b>Lane Change/Merge</b>	0.2 million	192,000	0.20	39,000
<b>Rear-End Crashes, Driver Warning</b>	1.7 million	1,547,000	0.49	759,000



# Benefits and Cost of Selected ITS Crash Countermeasures

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\* Calculated on the basis of Crashes Prevented by Roadway Departure, Rear-End, lane Change and Merge Countermeasures

<sup>1</sup> Total Cost is based upon 10 million vehicles per year with ITS countermeasures installed in the entire motor vehicle fleet.